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Robinson-Trautman Einstein-Maxwell fields of Petrov type D

In the quest for exact solutions of the Einstein-Maxwell (EM) equations a considerable amount of research has been devoted to the study of aligned EM fields, in which at least one of the principal null directions (PND) of the electromagnetic field **F** is parallel to a PND of the Weyl tensor, a so called Debever-Penrose (DP) direction. One of the main triumphs of this effort - spread out between 1960 and 1980– has been the complete integration of the field equations (with a possible non-0 cosmological constant Λ), for the Petrov type D doubly aligned non-null EM fields, in which \emph{both} real PNDs of **F** are parallel to a corresponding double DP vector, the so called ''class $\mathcal{D}$ metrics". In a recent systematic treatment of the non aligned algebraically special EM fields it was noted that, at least for non-0 Λ, the double alignment condition of the class $\mathcal{D}$ metrics is actually a consequence of their multiple DP vectors being geodesic and shear-free. A natural question therefore arises as to whether EM solutions exist which are of Petrov type D, have $\Lambda = 0$ and in which the two real DP vectors $\mathbf{k}, \ell$ are geodesic and shearfree, but are \emph{both non aligned} with the PND's of **F**. Recently [Class. Quantum Grav. 37, 21, 2020] we have been able to answer this question affirmatively, by completing the full integration of the EM field equations for the double Robinson-Trautman family, under the additional assumption that also the complex eigenvectors of the canonical Weyl-tetrad are hypersurface-orthogonal.

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